BusWorks® 900PB Series
ProfiBus/RS485 Network I/O Modules

Model 981PB-2012 12 Active-Low Digital Inputs
Model 982PB-2012 12 Sinking Digital Outputs
Model 983PB-2012 12 Tandem Digital Input/Output

USER'S MANUAL

ACROMAG INCORPORATED
30765 South Wixom Road
P.O. BOX 437
Wixom, MI 48393-7037 U.S.A.

Tel: (248) 624-1541
Fax: (248) 624-9234

Copyright 2002, Acromag, Inc., Printed in the USA.
Data and specifications are subject to change without notice.

8500-689-D04J008

TABLE OF CONTENTS

Symbols on equipment:

Means "Refer to User's Manual (this manual) for additional information".

The information of this manual may change without notice. Acromag makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Further, Acromag assumes no responsibility for any errors that may appear in this manual and makes no commitment to update, or keep current, the information contained in this manual. No part of this manual may be copied or reproduced in any form without the prior written consent of Acromag, Inc.

IMPORTANT SAFETY CONSIDERATIONS

You must consider the possible negative effects of power, wiring, component, sensor, or software failure in the design of any type of control or monitoring system. This is very important where property loss or human life is involved. It is important that you perform satisfactory overall system design and it is agreed between you and Acromag, that this is your responsibility.

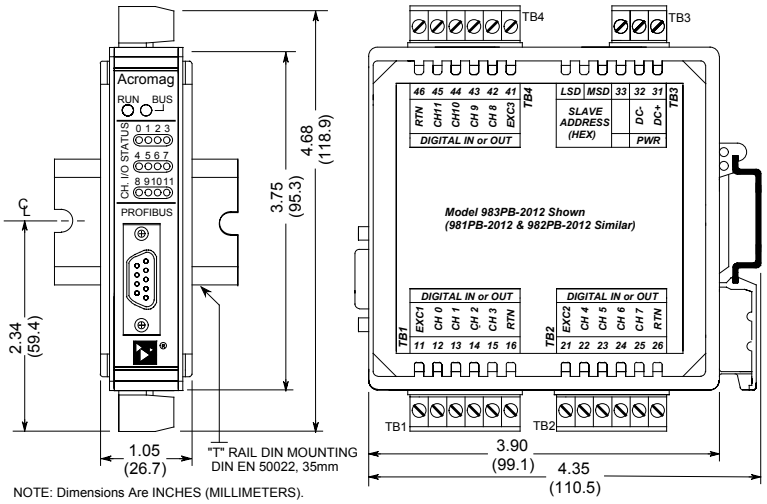
GETTING STARTED

MOUNTING AND DIMENSIONS..... 3
CONTROLS & INDICATORS..... 3
ISOLATION BARRIERS..... 3
SETTING SLAVE ADDRESS..... 4
I/O PULLUP RESISTOR INSTALLATION..... 4
CONNECTIONS..... 5
DIN-Rail Mounting And Removal..... 5
Network..... 5
Power..... 7
Digital Inputs..... 7
Digital Outputs..... 8
Earth Ground..... 9
TROUBLESHOOTING..... 10
Tips For Building ProfiBus Networks..... 10
Top Four Common ProfiBus Problems..... 11
Troubleshooting Tools..... 11
Using Connectors To Troubleshoot..... 11
Diagnostics Function..... 12
Diagnostics Table..... 12

TECHNICAL REFERENCE

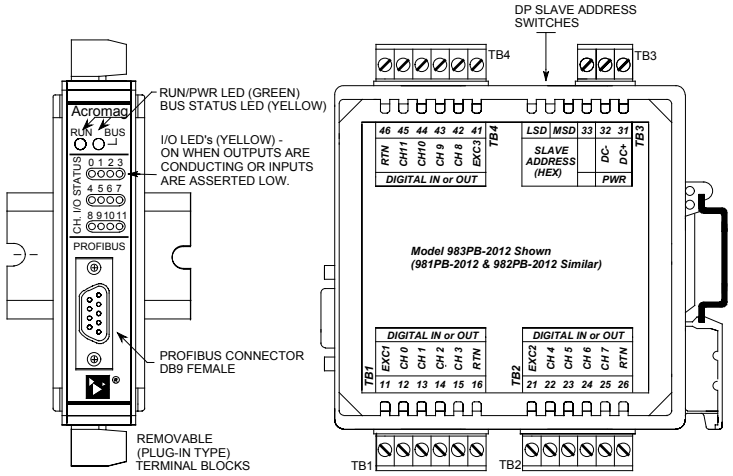
KEY FEATURES..... 13
HOW IT WORKS..... 14
SPECIFICATIONS..... 15
Model Numbers..... 15
Digital Inputs..... 15
Digital Outputs..... 15
General Specifications..... 16
Enclosure and Physical..... 16
Agency Approvals..... 17
Environmental..... 17
Communication Interface..... 18
Controls & Indicators..... 19
Module Specific Parameters..... 19
Data Types..... 20

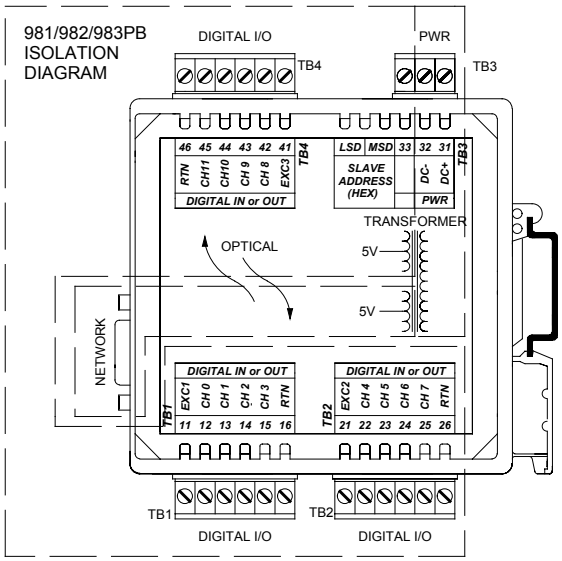
Windows® is a registered trademark of Microsoft Corporation.
Profibus® is a registered trademark of ProfiBus Trade Organization.
All trademarks are the property of their respective owners.



NOTE: Dimensions Are INCHES (MILLIMETERS).

MODEL 981/982/983PB ENCLOSURE DIMENSIONS





MOUNTING AND DIMENSIONS

Unit mounts to "T" type DIN rails (35mm, type EN50022).

Units may be mounted side-by-side on 1-inch centers.

***WARNING:** IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with exposure to voltages greater than or equal to 75VDC or 50VAC.*

CONTROLS & INDICATORS

Green Run LED will stay ON if power is on and unit is OK, and will blink if unit fails.

Yellow BUS LED will turn ON if module is connected to the network and in data exchange mode.

Yellow I/O LED's will turn ON if output switch is closed, or input signal is asserted low.

ISOLATION BARRIERS

Dashed Lines denote isolation barriers.

The I/O circuit, network, and power circuit are isolated from each other for safety and noise immunity.

SETTING SLAVE ADDRESS

Address is set to 126 (7EH) from factory. This address is reserved for commissioning purposes only.

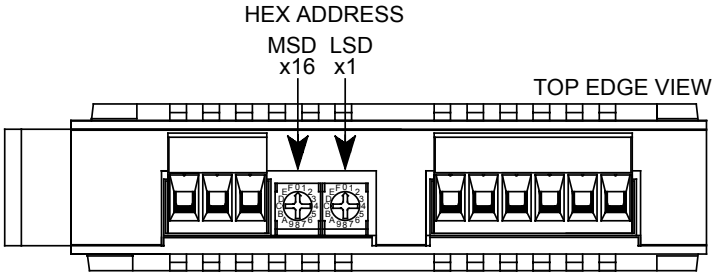
Locate hexadecimal address switches in recessed opening next to power terminals.

Use a screwdriver to rotate these switches to set a unique valid address from 0 to 125.

If the switches are set to a valid address from 0-125, then the switch setting determines the slave address and the Set Slave Address command will be rejected.

If these switches are instead set to 126 (7EH) upon power-up (or 126 to 254), the unit will retrieve its address from the internal EEPROM, which is modified via the Set Slave Address command.

If these switches are set to 255 (FFH) upon power-up, this will return the address in EEPROM to 126 (7EH).



SET SWITCHES TO A VALID SLAVE ADDRESS FROM 0 TO 125 (00H TO 7DH)

1. Choose a slave address from 0-125 and locate highest MSD number less than this address. Set MSD switch to this number's corresponding HEX digit.

MSD x16		0	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240
	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
LSD x1	DEC	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

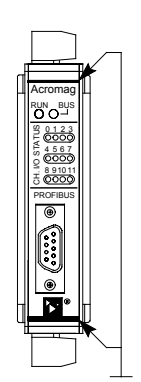
2. Determine the DECimal remainder and set the LSD switch to its corresponding HEX digit.

The address stored in the internal EEPROM is modified via the Set Slave Address command. If the address switches are set to 126 (or 126 to 254) upon power-up, the module will retrieve the last address stored within its EEPROM (126 from the factory). With both the internal EEPROM and external switch addresses set to 126, the unit will await the Set Slave Address command after power-up, before proceeding to the parameterization state (address 126 cannot be used in data exchange mode and is reserved for commissioning purpose only). You must use the Set Slave Address command to change the internal (EEPROM) address following power-up in order to proceed. However, if the switches are set to an address less than 126 upon power-up, then the switches determine the slave address and the EEPROM setting is ignored. You can later restore the internal EEPROM setting to 126 by powering the unit up with the address switches set to 255 (FF). You would then power the unit up again with these switches set to 126 in order to place the unit in commissioning mode.

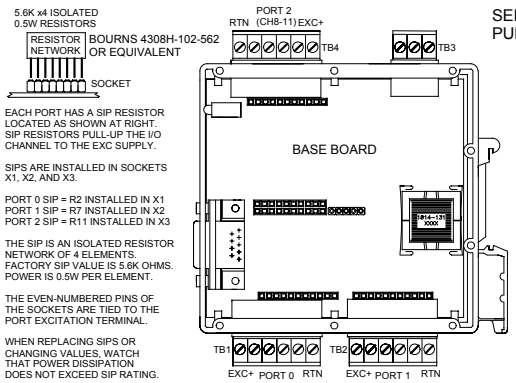
I/O PULLUP RESISTOR INSTALLATION

5.6KΩ I/O Pullup resistors are already installed from the factory. You do not need to refer to this information unless you need to change or remove these resistors.

You must connect excitation and/or install pull-ups for proper operation. I/O terminals must not be left floating.



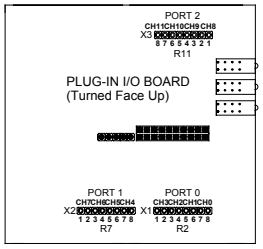
USE SMALL SCREW DRIVER TO PRY OFF SIDE COVER. COVER IS HELD IN PLACE WITH EIGHT SNAP PINS. CAREFULLY SEPARATE I/O BOARD FROM BASE BOARD.


5.6K x4 ISOLATED 0.5W RESISTORS
RESISTOR NETWORK
BOURNS 4308H-102-562 OR EQUIVALENT
SOCKET
EACH PORT HAS A SIP RESISTOR LOCATED AS SHOWN AT RIGHT. SIP RESISTORS PULL-UP THE I/O CHANNEL TO THE EXC SUPPLY.
SIPS ARE INSTALLED IN SOCKETS X1, X2, AND X3.
PORT 0 SIP = R2 INSTALLED IN X1
PORT 1 SIP = R7 INSTALLED IN X2
PORT 2 SIP = R11 INSTALLED IN X3
THE SIP IS AN ISOLATED RESISTOR NETWORK OF 4 ELEMENTS. FACTORY SIP VALUE IS 5.6K OHMS. POWER IS 0.5W PER ELEMENT.
THE EVEN-NUMBERED PINS OF THE SOCKETS ARE TIED TO THE PORT EXCITATION TERMINAL.
WHEN REPLACING SIPS OR CHANGING VALUES, WATCH THAT POWER DISSIPATION DOES NOT EXCEED SIP RATING.
PORT 2 (CH8-11)
RTN
EXC+
TB4
TB3
BASE BOARD
TB1
TB2
EXC+ PORT 0 (CH0-3) RTN
EXC+ PORT 1 (CH4-7) RTN

CAUTION: HANDLE CIRCUIT USING ESD-SAFE PROCEDURES.

981PB/982PB/983PB SHOWN WITH SIDE COVER REMOVED AND I/O BOARD SEPARATED

SERIES 981PB/982PB/983PB SIP PULLUP RESISTOR SOCKET LOCATION



PULLUPS ARE LOCATED IN SOCKETS ON PLUG-IN I/O BOARD AS SHOWN HERE

WHEN REPLACING COVER, ALIGN ALL PINS, THEN SNAP TOGETHER IN SEQUENCE TO SECURE COVER.

To Remove or Replace Factory Pullup Resistors…

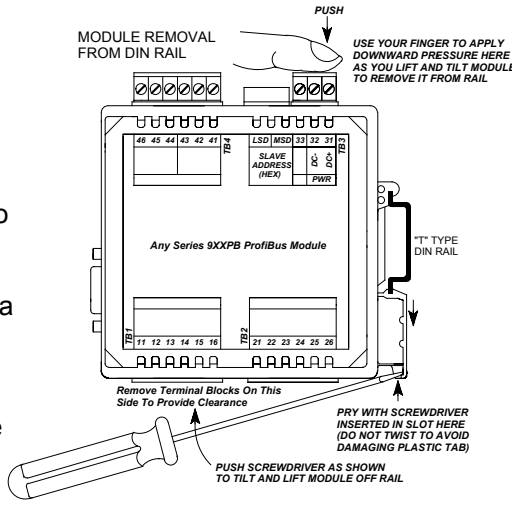
Locate pullup resistor SIP's installed in sockets of plug-in I/O board as shown above. You must remove the side cover and separate the two boards to remove or install these resistors. 5.6K resistor SIP's are installed from the factory. Remove these resistors if I/O channels are pulled up externally. Limit power in each SIP resistor to 0.4W maximum.

If your application delivers power to the I/O terminals rather than the excitation terminal, the internal pull-ups should be removed to avoid coupling current into adjacent port channels.

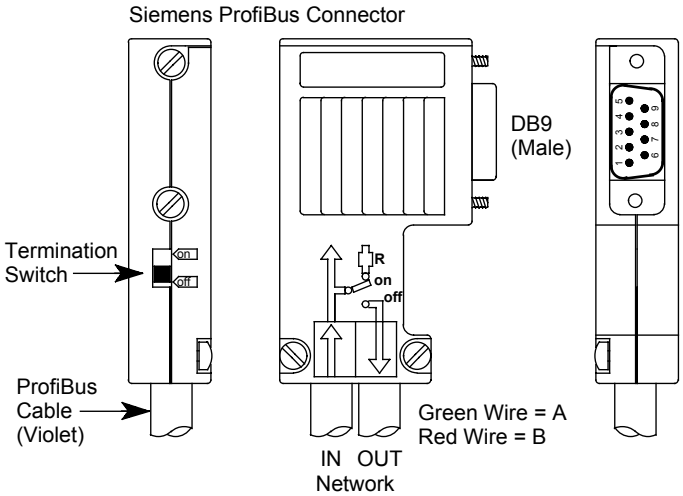
CONNECTIONS

DIN-Rail Mounting & Removal

When attaching the module to the T-type DIN rail, angle the top of the unit towards the rail and locate the top groove of the adapter over the upper lip of the rail. Firmly push the unit towards the rail until it snaps into place. To remove, first separate the input terminal block(s) from the bottom side of the module to create a clearance to the DIN mounting area. Next, while holding the module in place from above, insert a screwdriver into the lower arm of the DIN rail connector and use it as a lever to force the connector down until the unit disengages from the rail (do not twist the screwdriver to avoid damaging plastic).


MODULE REMOVAL FROM DIN RAIL
PUSH
USE YOUR FINGER TO APPLY DOWNWARD PRESSURE HERE AS YOU LIFT AND TILT MODULE TO REMOVE IT FROM RAIL
Any Series 9XXPB ProfiBus Module
"T" TYPE DIN RAIL
Remove Terminal Blocks On This Side To Provide Clearance
PRY WITH SCREWDRIVER INSERTED IN SLOT HERE (DO NOT TWIST TO AVOID DAMAGING PLASTIC TAB)
PUSH SCREWDRIVER AS SHOWN TO TILT AND LIFT MODULE OFF RAIL

Network



Do not mix RS485 A & B connections. Green wire is A, red wire is B.
You MUST terminate the network at both ends only.
Termination resistors are integrated in the ProfiBus connector.
When you switch termination ON, the out-going connections are disconnected from the network.

Use ProfiBus connectors similar to the one shown at left (Siemens version shown).

Always use ProfiBus cable per DIN 19245 and EN 50170.

When building cables, do not mix A & B connections. Green wire is A, Red wire is B.

The connector must have built in inductors in order to operate at the higher baud rates.

CONNECTIONS

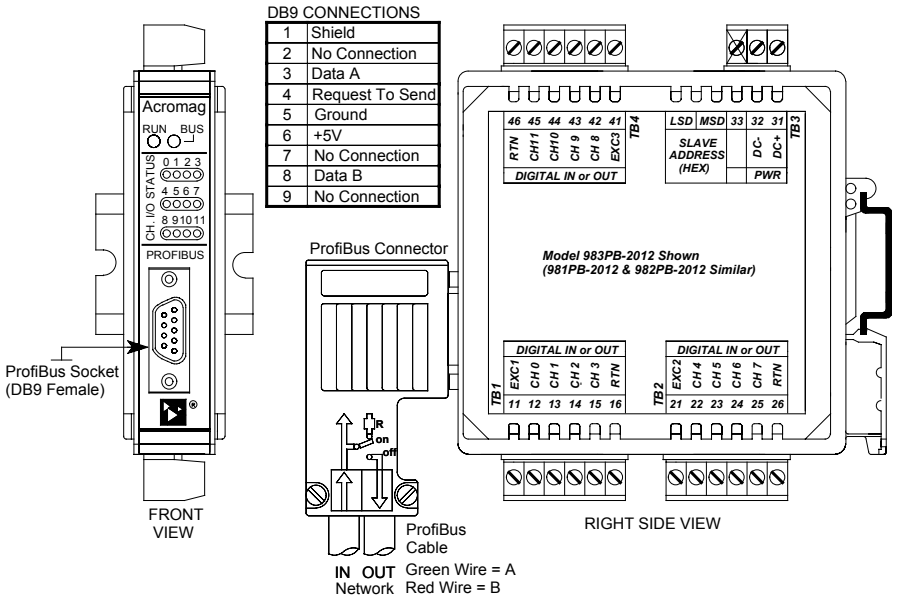
Network

GSD Files:

981PB-2012 ACRO06F3.GSD
Ident_Number=06F3H

982PB-2012 ACRO06F2.GSD
Ident_Number=06F2H

983PB-2012 ACRO06F1.GSD
Ident_Number=06F1H



IMPORTANT: *Do not connect earth ground to logic Ground (DB9 Pin 5). Earth Ground should connect to Shield (Common to DB9 Pin 1).*

Note that Acromag modules also support the optional RTS direction control signal at Pin 4.

Network Length

Use Type A ProfiBus cable per EN 50170. Keep line lengths less than the length indicated below for your transmission rate. For baud rates not shown, the lower length of the closest range end points apply (i.e. 100M at 3MB).

Bus Segment Length Limit Per Baud Rate For Type A Bus Cable

BAUD	9.6K	19.2K	93.75K	187.5K	500K	1.5MB	12MB
Type A	1200M	1200M	1200M	1000M	400M	200M	100M

Termination

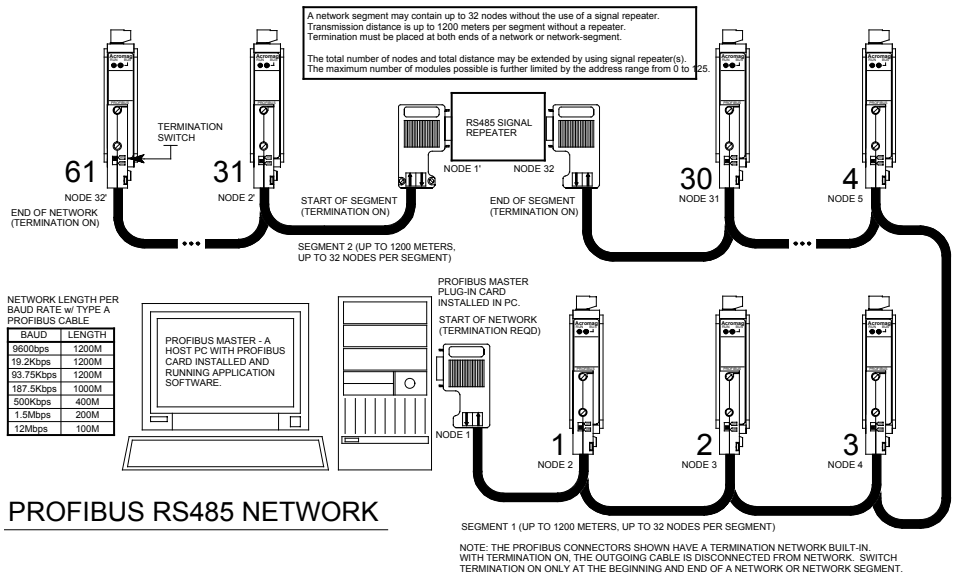
The network must be terminated at both ends only. Most ProfiBus connectors include a switch for termination as shown above. Note that this switch will also disconnect the outgoing network signal.

Example ProfiBus System Connections

Up to 125 slave modules may network together with a class 1 master using four repeaters (one repeater every 31 nodes). Address 0 is typically reserved for the class 1 master.

Note: 12Mbps installations require a minimum cable length of 1M between stations.

TIP: A recommended RS485 repeater for ProfiBus is the Siemens 6ES7 972-0AA01-0XA0.


A network segment may contain up to 32 nodes without the use of a signal repeater.
Transmission distance is up to 1200 meters per segment without a repeater.
Termination must be placed at both ends of a network or network-segment.
The total number of nodes and total distance may be extended by using signal repeater(s).
The maximum number of modules possible is further limited by the address range from 0 to 125.
TERMINATION SWITCH
RS485 SIGNAL REPEATER
61
NODE 32
31
NODE 2
NODE 1
NODE 32
30
NODE 31
4
NODE 5
END OF NETWORK (TERMINATION ON)
START OF SEGMENT (TERMINATION ON)
END OF SEGMENT (TERMINATION ON)
SEGMENT 2 (UP TO 1200 METERS, UP TO 32 NODES PER SEGMENT)
NETWORK LENGTH PER BAUD RATE w/ TYPE A PROFIBUS CABLE
BAUD LENGTH
9600bps 1200M
19.2Kbps 1200M
93.75Kbps 1200M
187.5Kbps 1000M
500Kbps 400M
1.5Mbps 200M
12Mbps 100M
PROFIBUS MASTER - A HOST PC WITH PROFIBUS CARD INSTALLED AND RUNNING APPLICATION SOFTWARE.
PROFIBUS MASTER PLUG-IN CARD INSTALLED IN PC.
START OF NETWORK (TERMINATION REQD)
NODE 1
1
NODE 2
2
NODE 3
3
NODE 4
PROFIBUS RS485 NETWORK
SEGMENT 1 (UP TO 1200 METERS, UP TO 32 NODES PER SEGMENT)
NOTE: THE PROFIBUS CONNECTORS SHOWN HAVE A TERMINATION NETWORK BUILT-IN. WITH TERMINATION ON, THE OUTGOING CABLE IS DISCONNECTED FROM NETWORK. SWITCH TERMINATION ON ONLY AT THE BEGINNING AND END OF A NETWORK OR NETWORK SEGMENT.

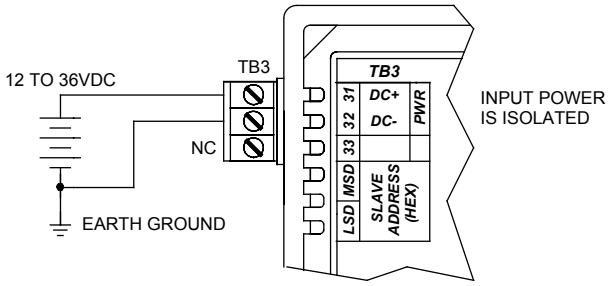
CONNECTIONS

Power

Voltage	Current
12VDC	224mA
15VDC	170mA
24VDC	104mA
36VDC	74mA

CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize equipment before servicing.

✓ Connect 12-36V DC to the power terminals labeled DC+ & DC-. Observe proper polarity. For supply connections, use No. 14 AWG wires rated for at least 75°C. **CAUTION:** Do not exceed 36VDC peak.



IMPORTANT – External Fuse: If unit is powered from a supply capable of delivering more than 1A to the unit, it is recommended that this current be limited via a high surge tolerant fuse rated for a maximum current of 1A or less (for example, see Bel Fuse MJS1).

✓ Connect digital input signals to the input terminals. Refer to the figures below:

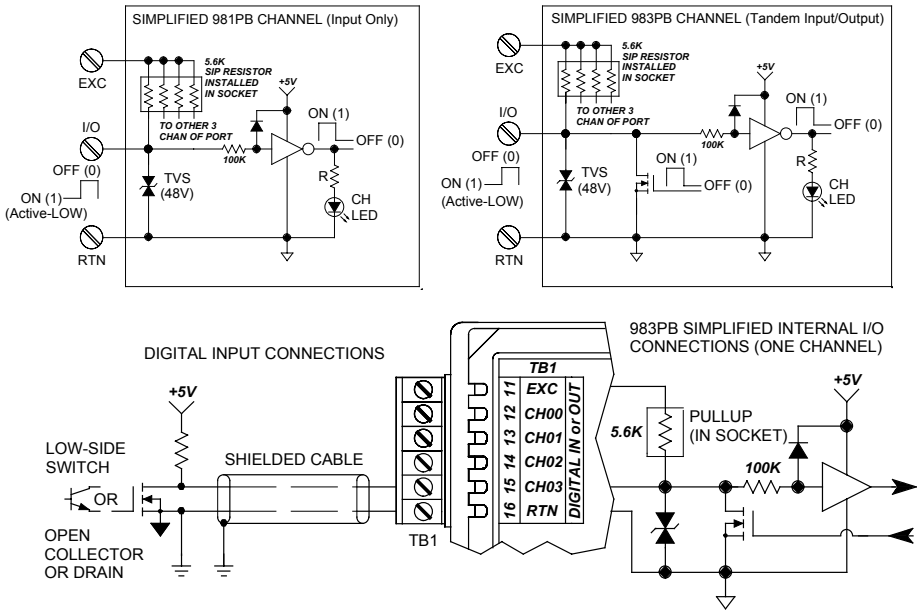
Digital Inputs (981PB & 983PB Only)

Inputs are active-low.

Input threshold is TTL compatible.

Limit Input Voltages to 35V maximum.

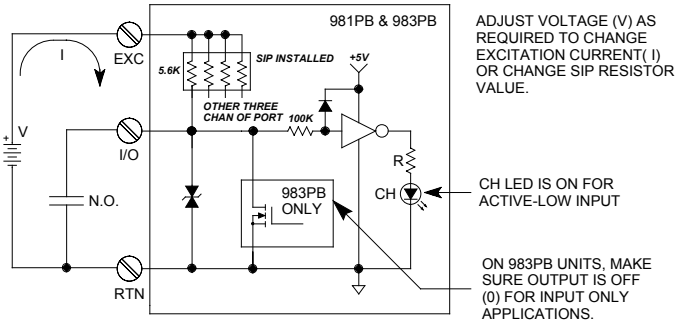
***Note:** Do not allow EXC or unused inputs to float. If pull-ups are installed, this will cause one I/O signal to pull the other floating port channels via the pull-ups and common EXC lead connection.*



Refer to the examples below for other types of input connections.

DRY-CONTACT RELAY CONNECTIONS - NORMALLY OPEN

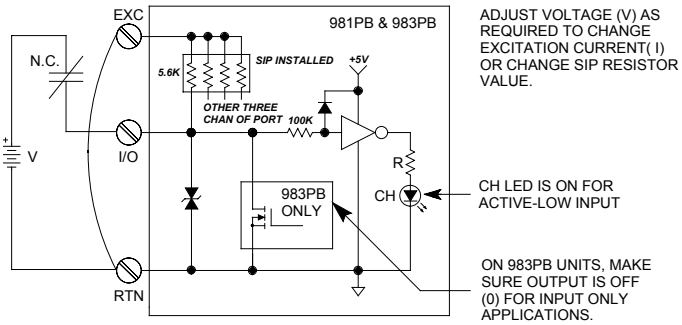
Normally Open Dry Contact Relay.



CONNECTIONS

Normally Closed Dry Contact Relay.

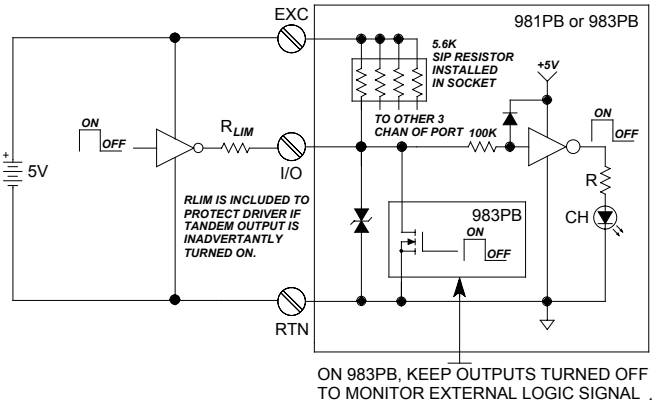
DRY-CONTACT RELAY CONNECTIONS - NORMALLY CLOSED



Digital Inputs

Digital TTL Logic Monitor

LOGIC (TTL) MONITOR (981PB & 983PB ONLY)

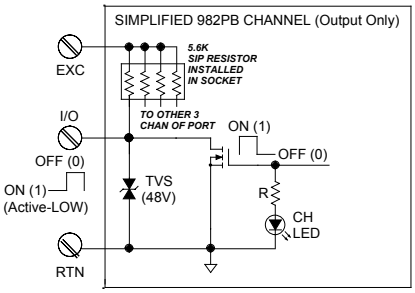


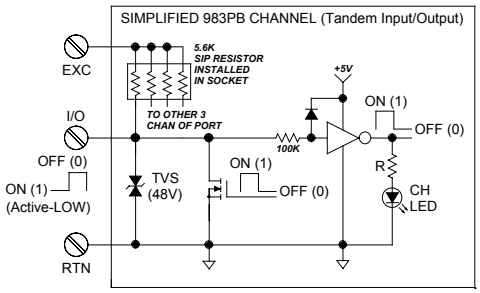
Digital Outputs (982PB & 983PB Only)

Outputs are the open-drains of DMOS mosfet switches for DC current-sinking applications only.

Outputs turn OFF (open) following a software or power-on reset of the module.

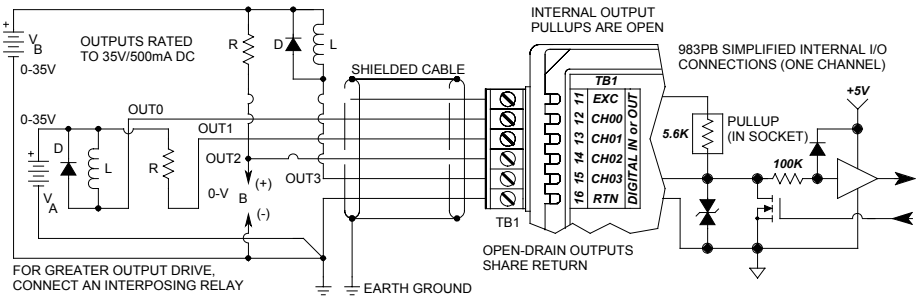
✓ Connect digital outputs to the output terminals. Refer to figures below:





DIGITAL OUTPUT CONNECTIONS

POSSIBLE VARIATIONS - CURRENT SINKING DC APPLICATIONS ONLY



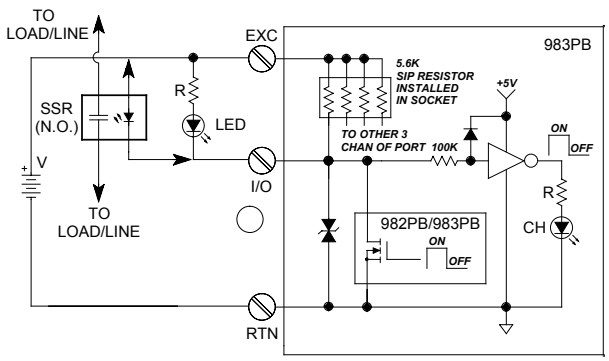
Digital Ouputs (982PB & 983PB Only)

IMPORTANT – Add Protection With Inductive Loads: Outputs already include internal reverse-bias shunt diodes to help protect the output switch from damage due to the high reverse-bias voltages generated when switching inductive loads. You should add external protection near the inductive load to prevent these transients from being sent along the connection wires. Place a diode (1N4006 or equivalent) across an inductive load with the cathode to (+) and the anode to (-).

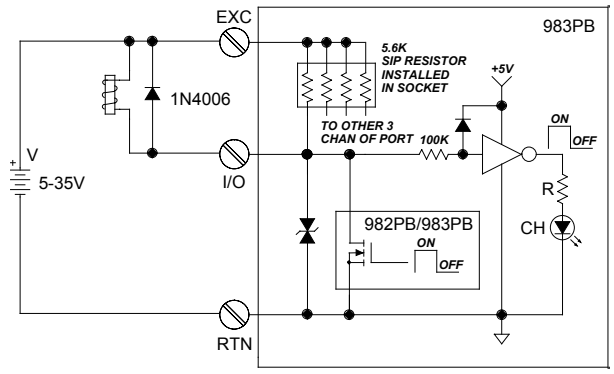
Refer to the examples below for other types of output connections.

Examples:
- *Solid-State Relay (SSR) or LED Driver.*
- *Relay Coil or Solenoid Driver (Note Protection).*
- *Lamp Driver.*

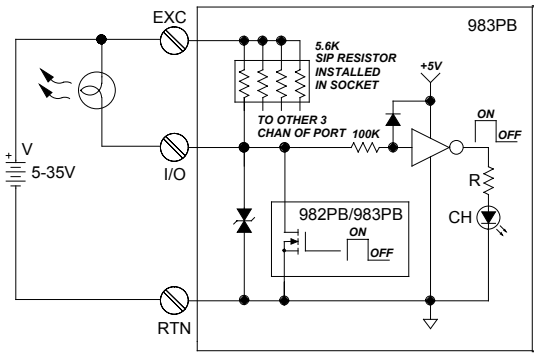
SOLID-STATE RELAY (SSR) OR LED DRIVER



RELAY COIL/SOLENOID DRIVER



INCANDESCENT LAMP CONTROL



Earth Ground

✓ Connect Earth Ground as shown in the connection drawing below. Additionally, ground the ProfiBus cable as shown below.

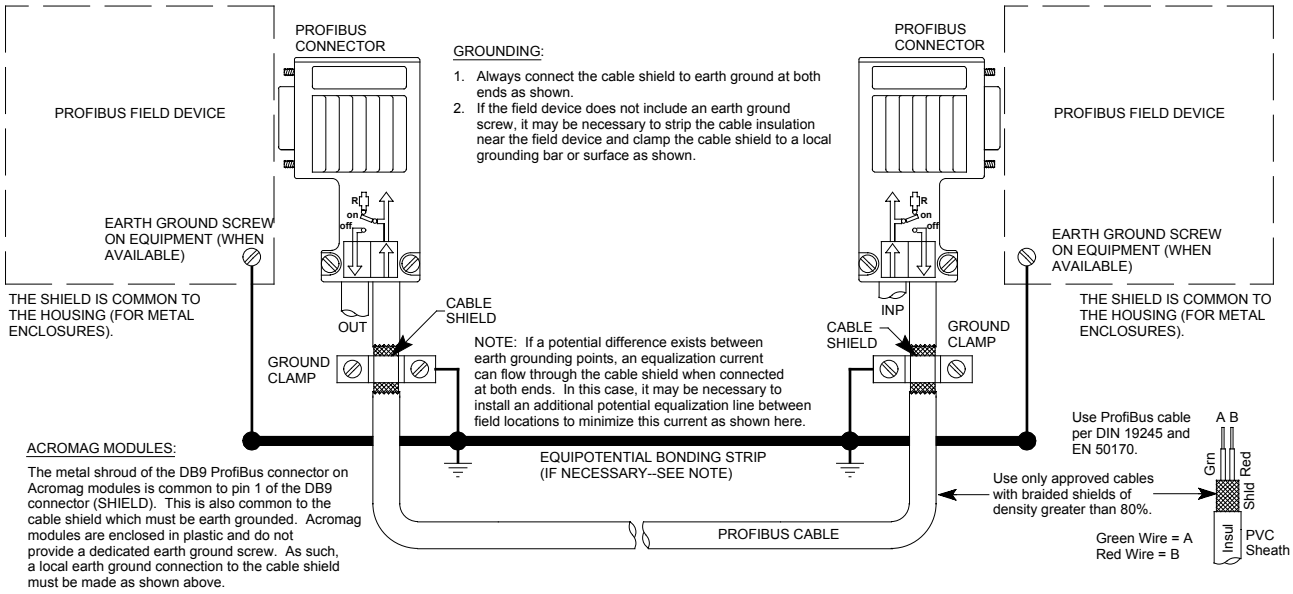
The ground connections noted are recommended for best results. If sensors are already grounded, use caution and avoid making additional ground connections which could create ground loops.

The plastic module housing does not require earth ground.

Warning: *To comply with safety and performance standards, use shielded cable and connect earth ground as noted. Failure to use good wiring and grounding practices may be unsafe and hurt performance.*

CONNECTIONS

PROFIBUS WIRING AND GROUND


PROFIBUS FIELD DEVICE
PROFIBUS CONNECTOR
EARTH GROUND SCREW ON EQUIPMENT (WHEN AVAILABLE)
THE SHIELD IS COMMON TO THE HOUSING (FOR METAL ENCLOSURES).
OUT
CABLE SHIELD
GROUND CLAMP
GROUNDING:
1. Always connect the cable shield to earth ground at both ends as shown.
2. If the field device does not include an earth ground screw, it may be necessary to strip the cable insulation near the field device and clamp the cable shield to a local grounding bar or surface as shown.
NOTE: If a potential difference exists between earth grounding points, an equalization current can flow through the cable shield when connected at both ends. In this case, it may be necessary to install an additional potential equalization line between field locations to minimize this current as shown here.
INP
CABLE SHIELD
GROUND CLAMP
EQUIPOTENTIAL BONDING STRIP (IF NECESSARY--SEE NOTE)
PROFIBUS CABLE
ACROMAG MODULES:
The metal shroud of the DB9 ProfiBus connector on Acromag modules is common to pin 1 of the DB9 connector (SHIELD). This is also common to the cable shield which must be earth grounded. Acromag modules are enclosed in plastic and do not provide a dedicated earth ground screw. As such, a local earth ground connection to the cable shield must be made as shown above.
Use ProfiBus cable per DIN 19245 and EN 50170.
A B
Grn
Red
Shld
Insul
PVC Sheath
Use only approved cables with braided shields of density greater than 80%.
Green Wire = A
Red Wire = B

TROUBLE-SHOOTING

The module routinely performs internal diagnostics following power-up or reset. During this period, the green "Run" LED will flash for a moment. If the diagnostics complete OK, the "Run" LED will stop flashing after a few seconds and remain ON. This indicates the unit is operating normally. Once the unit has passed through the initialization, parameterization, and configuration states, and is in data exchange mode, the yellow BUS LED will be ON. If the BUS LED is OFF and the unit is connected to the network, then this is indicative of an initialization problem.

Tips For Building ProfiBus Networks

- Follow the ProfiBus installation guidelines.
- Use the recommended cable and connectors of the standard.
- Verify that none of the wires are broken or shorted.
- Don't mix the A & B lines. Use green wire for A and red wire for B.
- Do not exceed the recommended segment length for the baud rate.
- Make sure that there are no more than 32 RS-485 devices per segment (including the master device and the repeater).
- Check for proper termination of all copper-wire network segments (an RS-485 segment must have a termination resistor at both ends of the segment only).
- All activated terminations must be powered all the time. If this is not possible, then consider using an active-termination box.
- Check whether the station address is set to the correct value.
- If your network connects between buildings or runs through hazardous environments, consider the use of fiber-optics.
- Avoid drop lines and keep their length within the specified maximum. For T-drops, consider using repeaters and active-bus terminations.

Top Four Common ProfiBus Problems

1. Incorrect slave address set at the slave.
2. ProfiBus connector between the master and slave has its termination switch turned ON.
3. Incorrect module configuration sent to slave.
4. Configuration is based on outdated GSD file information.

Troubleshooting Tools

There are several models of handheld devices on the market that simplify the installation and troubleshooting of ProfiBus networks. The more sophisticated units include LCD displays that read out errors directly. Two of these of these devices are referenced below:

Hand-Held ProfiBus Network Maintenance Tools

Manufacturer	Part Number	Special Features
Siemens	BT 200	Primarily a Cable Tester
Comsoft	NetTest II Set 4000-7-06C-J	Includes DP Mono-Master Functionality

In general, these devices can be used to check the network wiring before devices are connected to the bus and are often used to indicate:

- Whether the A and B lines have been switched.
- Whether a short exists between the A & B lines and shield.
- The occurrence of a wire-break in the A or B line, or shield line.
- Improper termination.

These devices can also be used to check the RS-485 interface of ProfiBus devices after they have been connected. They may include the following functions:

- Create a list of all stations connected to a network (useful for identifying missing or "offline" devices).
- Test individual stations and help identify duplicate addresses.
- Measure the distance along a network segment to verify whether it complies with Profibus requirements for distance and data rate.
- Detect signal reflections along the network, useful for locating bus line interruptions and discontinuities.

Acromag strongly suggests the use of these tools for building and maintaining ProfiBus networks.

Note that Profichip also offers a Profibus connector (PA003100) that includes 4 network diagnostic LED's that may be helpful in trouble-shooting your network (see table below).

Using Connectors To Troubleshoot

The standard 9-pin ProfiBus connectors with integrated termination resistors are also helpful in troubleshooting segments of the network. In most of these connectors, when the termination resistors are switched ON, the outgoing portion of the connector is disconnected. As such, you can selectively disable segments of the network until you find the branch that is causing the problem. For example, if your handheld unit is connected to the beginning of a network and indicates a wire break, you can selectively switch off portions of the network and recheck your handheld unit to help pin point the portion of the network that is causing the problem. Below are some ProfiBus connectors that we recommend:

Using Connectors To Troubleshoot

Preferred Bus Connectors

Manuf.	Part Number	Special Features
Siemens	6ES7972-0BA12-0XA0	Switchable Termination
Siemens	6ES7972-0BB12-0XA0	Adds PB Interface (Piggy Back DB9 For Diagnostic Connection)
Profichip	PA003100	Adds PB Interface and 4 Diagnostic LED's For Trouble-Shooting.

Diagnostics Function

ProfiBus includes a rich diagnostic function that can be used to troubleshoot ProfiBus devices. This function contains 6 bytes of standard diagnostic information, plus up to an additional 238 bytes of device specific diagnostic information. Most configuration tools support this command and can read the diagnostic information from the Profibus device.

Diagnostics Table

If your problem still exists after checking your wiring and reviewing this information, or if other evidence points to another problem with the unit, an effective and convenient fault diagnosis method is to exchange the module with a known good unit. Acromag's Application Engineers can provide further technical assistance if required. Complete repair services are also available from Acromag.

SYMPTOM	POSSIBLE CAUSE	POSSIBLE FIX
Yellow BUS LED does not light.	Initialization Problem. LED ON if module in data exchange state. Both the internal EEPROM and external address switches are set to an address of 126.	Check Station Address. Is GSD file correct. Check for wiring error. Module awaiting Set Slave Address command in order to complete initialization. Alternately, set switches from 0-125 and re-power.
Cannot communicate.	Power ON at the module and/or RS485 converter?	Check power. Is green RUN LED ON?
	Is address correct?	Check slave address setting
	Is the termination switch of the Profibus connector at the prior node turned on?	Switch Termination on only at the **ends** of the network. With termination switch on, the outgoing connections are disconnected from the network chain.
Yellow BUS LED turned OFF.	Communication Halted.	Cycle power to reset unit. Investigate grounding.
Continuous flashing green RUN LED.	Internal firmware problem.	Return module for service.
Many Communication Errors.	Missing Termination Resistors?	Termination resistors must be placed only at both ends of a network or segment.
	Is baud rate too high for distance?	Maximum distance is limited below 1200 meters as baud rate is increased above 93.75Kbps (see Table).
Outputs Not Working.	Missing excitation connection?	Connect an excitation supply between the port EXC and RTN terminals
	Missing pull-up resistors?	Install SIP resistor in socket on board for port of interest.

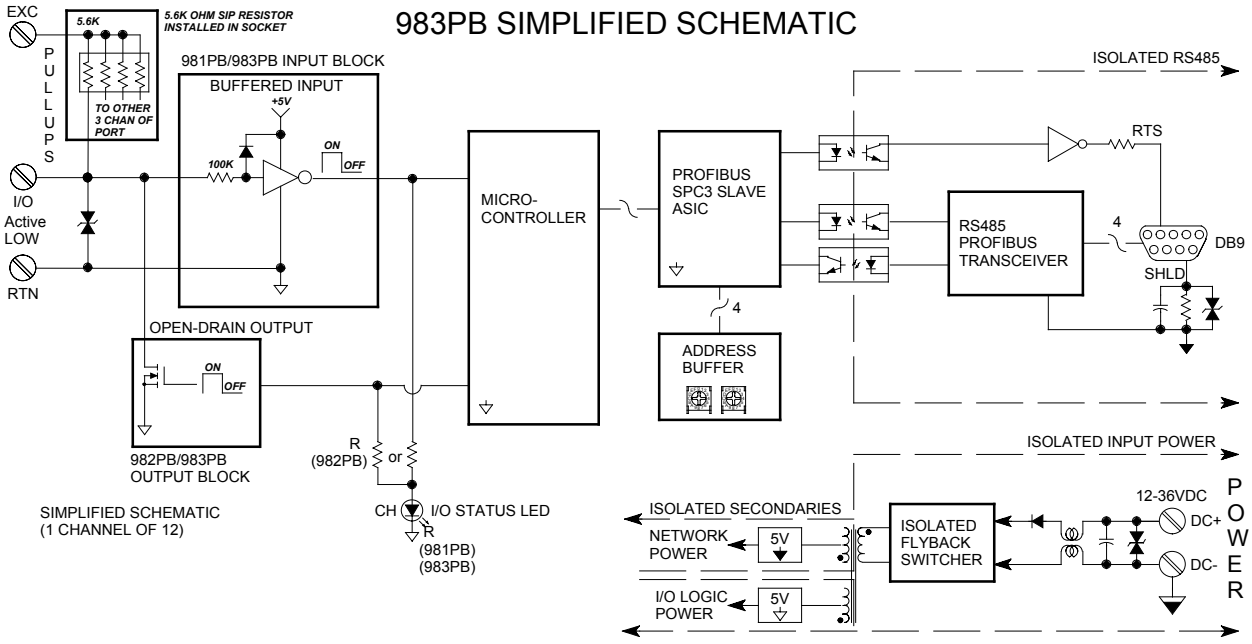
TECHNICAL REFERENCE

KEY FEATURES

- **PTO Certified** - Certified by the ProfiBus Trade Organization.
- **Safety Agency Approvals** – CE, UL, & cUL listed, plus Class 1; Division 2; Groups A, B, C, D approval.
- **Fully Independent Slave w/ Direct I/O Connection** – Self-contained unit does not require special bus couplers, power supply, or rack mount to operate.
- **Plug-In Terminal Blocks & DIN-Rail Mount -** Make mounting, removal, and replacement easy.
- **Industry Standard ASIC** – Siemens SPC3 intelligent ASIC for ProfiBus.
- **Isolated RS485/ProfiBus Network Interface** – Immune to noise & can operate over long distances. Allows many modules to network together.
- **Auto-Baud Rate Detection** – The baud rate is set automatically.
- **High-Speed Data Rates** – Half-duplex RS485 up to 12M baud.
- **Includes RTS Support** – ProfiBus interface includes the optional RTS (Request-To-Send) direction control.
- **Failsafe Mode Support –** Slave outputs can be sent to a failsafe state if the slave master fails.
- **Supports Set_Slave_Address Command –** Allows unit to have its address set via software.
- **Supports Sync & Freeze –** Useful for synchronization of output control.
- **Nonvolatile Reprogrammable Memory** – Allows the functionality of this device to be reliably reprogrammed thousands of times.
- **Fully Isolated** – I/O channels, network, and power are all isolated from each other for safety and increased noise immunity.
- **Flexible Discrete Inputs and Outputs** - High voltage & current open-drain outputs provide direct (low-side) control of external devices. Buffered inputs allow outputs to be read back, or input levels to be monitored.
- **Tandem Input/Output Circuitry (983PB Only)** - Input buffers are connected in tandem with open-drain outputs for convenient loop-back monitoring of the output state.
- **Convenient Pullup Resistors Mounted In Sockets** – SIP resistors are installed in sockets on the I/O board and provide input and output pull-ups to the excitation supply. These SIP resistors can be easily removed or exchanged according to your application.
- **Outputs Have Built-in Protection** – Over-temperature and over-current shut-down protection is built-in and outputs include active clamping circuitry for switching inductive loads.
- **LED Indicators** – Yellow LED's indicate I/O state (active-low). Green LED indicates power. Yellow BUS LED indicates data exchange mode.
- **Watchdog Timer Built-In** – Standard for the ASIC and operates in the data exchange mode if communication with the master is lost.
- **Self-Diagnostics & Built In Watchdog** - For easy maintenance and troubleshooting. Includes a hardware watchdog timer built into the microcontroller that causes it to initiate a self reset if the controller ever "locks up" or fails to return from an operation in a timely manner.
- **Wide-Range DC-Power** – Wide range diode-coupled for use with redundant supplies, and/or battery back-up.
- **Hardened For Harsh Environments** - For protection from RFI, EMI, ESD, EFT, & surges. Has low radiated emissions per CE requirements.
- **Wide Ambient Operation** – Reliable over a wide temperature range.

HOW IT WORKS

These digital I/O modules will interface with any mix of up to twelve digital input and/or output signals according to the model, and provide an isolated RS485/ProfiBus interface for configuration, monitoring, and control of the I/O. Outputs of these models are the open-drains of n-channel mosfets (982PB & 983PB). Input buffers are connected in tandem with the drain circuits via series 100KΩ resistors, and over-voltage clamps to +5V are connected to the buffer inputs (981PB & 983PB). I/O terminals also include transient suppression. Sockets are installed for installation of optional input or output drain pull-up resistors, and 5.6K SIP resistors are installed from the factory. These resistors are pulled up to an external supply connected to the EXC and RTN terminals. These modules implement the ProfiBus protocol via an industry-standard SPC3 ASIC from Siemens. This ASIC acts like a RAM or UART chip to the internal microcontroller and completely handles the requirements of the protocol standard. The ASIC communicates with the network via an optically isolated RS485 transceiver. It transfers network data to the microcontroller and automatically provides the response to the bus. The microcontroller completes the information transfer according to its I/O type and embedded program. I/O lines of the microcontroller switch outputs ON/OFF and sample the digital inputs. Embedded configuration parameters are stored in non-volatile memory integrated within the micro-controller. A wide input switching regulator (isolated flyback) provides isolated power to the I/O circuit and the RS485 port. Refer to the simplified schematic shown below to gain a better understanding of the circuit.



SPECIFICATIONS

These DIN-rail mount, ProfiBus DP slave, digital I/O modules include twelve digital inputs (981PB), twelve digital outputs (982PB), or twelve combination digital input/output channels (983PB), and provide an isolated RS485/ProfiBus network interface. Units are DC-powered and include reverse polarity protection. Outputs are open-drain, low-side switches. Inputs are active-low. Channel I/O, network, and power are isolated. Outputs have high voltage and current capacity for discrete on/off control of external devices. Non-inverting, buffered inputs provide support for digital level sensing, or for simply reading back the tandem output (983PB). I/O channels share common. Pull-up resistors to the port EXC supply (every four channels) are installed in sockets on the board. Non-volatile reprogrammable memory in the module stores configuration information.

Model Numbers

The ProfiBus model prefix "900" denotes the Series 900. The "PB" suffix denotes ProfiBus. Select 981PB for digital inputs, 982PB for digital outputs, or 983PB for tandem digital inputs and outputs. The four digit suffix of this model number represents the following options, respectively: "2" = ProfiBus DP; "0" = Default; "12" = 12 Channels.

981PB-2012 (Input)
982PB-2012 (Output)
983PB-2012 (Inp/Out)

Digital Inputs (981PB & 983PB Only)

Twelve active-low, buffered inputs, with a common connection (RTN). For DC voltage applications only. Inputs include transient suppression and have series connected 100KΩ resistors, plus diode over-voltage clamps to the internal +5V supply. Sockets are provided at each port (group of four channels) for installation of SIP resistor networks that serve as pullups to the port EXC supply terminal. 5.6K pull-up resistor SIP's are installed from the factory. External excitation is required for proper operation and is connected between the port EXC and RTN terminals.

Input Signal Voltage Range: 0 to +35VDC.
Input Current: 293uA, typical at 35VDC. This is computed as the applied input voltage minus 5.7V, divided by the series 100KΩ input resistance.
Input Signal Threshold: TTL compatible with 100mV of hysteresis, typical. Low-to-High threshold is 1.7VDC typical, High-to-Low threshold is 1.6VDC, typical. Limit logic transition to TTL levels of 0.8VDC (Max LOW level) and 2.0VDC (Min HIGH level).
Input Resistance: 100KΩ, typical.
Input Hysteresis: 100mVDC typical.
Input Response Time: 800ns typical, measured from input step to logic transfer at the ASIC. Actual input response will vary with interrupts.

Digital Outputs (982PB & 983PB Only)

Twelve open-drain, DMOS mosfet switches with a common source connection at the port RTN terminal. For DC voltage and current-sinking applications only. Outputs have built-in transient protection. Sockets are provided at each port (four channels) for quick replacement and installation of SIP resistor networks that serve as pullups to the port EXC supply terminal. 5.6K pull-up resistor SIP's are installed from the factory.

Output "OFF" Voltage Range: 0 to 35V DC. Limit voltage to 35V or less or damage to the unit may result.
Output "OFF" Leakage Current: : 0.1uA typical, 50uA maximum (mosfet only, 25°C, 35V). Does not include the tandem input bias current of 983PB models (see below).

Digital Outputs (982PB & 983PB Only)

To control higher voltages and/or currents, or for controlling AC, an interposing relay may be used (see Note).

Note (983PB): The 100KΩ series input buffer resistors in combination with the +5V voltage clamps at the input buffers will tend to increase the off-state drain current with increased drain voltage (up to 0.3mA at 35V). This is due to the fact that the input buffer circuitry and output mosfet drain circuitry are connected in tandem to the same I/O pin for the Model 983PB.

Output "ON" Current Range: 0 to 500mA DC, continuous (up to 6A total for all 12 channels combined). No deration required at elevated ambients. Group one RTN per each group of 4 outputs.

Output R_{ds} ON Resistance: 0.13Ω typical, 0.28Ω Maximum.

Output Response Time: 220us typical measured from output trigger at the ASIC to corresponding input transition at the ASIC. Actual switch time will vary with output load and interrupts.

Note: Per UL, when the outputs are used to control interposing relays for switching AC and DC devices of higher voltage/current, the coil ratings for the interposing relay shall not exceed 24VDC, 100mA.

General Specifications

I/O Pullups & Socket: I/O channels include sockets for installation of optional SIP resistor networks to act as pull-ups for the channel. These resistors are located on the plug-in I/O board (cover removal required). A SIP socket is included for each group of four channels (port) and a 5.6KΩ resistor SIP is installed from the factory. The even-numbered pins of these sockets (common leads) connect to the port EXC+ terminal. An external excitation supply is typically connected between the EXC+ and RTN terminals of the port. The recommended SIP resistor is a four isolated resistor type (8 pins) and may be obtained from Acromag or another vendor. These SIP resistors typically come rated for 0.2W, 0.3W, or 0.4W per element. For example, refer to Bourns 4308R-102, 4308M-102, or 4308H-102 parts. You may also refer to Dale CSC08C03, MSP08C03, or MSM08C-03 parts. The 5.6KΩ SIP provided is a high-power type from Bourns (part number 4308H-102-562) and is rated at 0.4W per resistor up to 70°C. See I/O Pullup Resistor Installation section for more information.

IMPORTANT: When selecting a SIP resistor, be sure to limit the individual resistor power dissipation to less than the rated power per element. This is 0.4W for the 5.6KΩ SIP resistor installed from the factory. Further, do not exceed 500mA of drain current per output, or 2A total per RTN terminal.

Excitation (External): External voltage is applied between the port EXC and RTN terminals and must be limited to 35V or less. The EXC terminal is tied to the even-numbered pins of the resistor SIP socket provided for each port or group of 4 channels.

Enclosure and Physical

Dimensions: 1.05 inches wide, 4.68 inches tall, 4.35 inches deep. Refer to the dimensions drawing at the front of this manual.

DIN Rail Mount: Type EN50022; "T" rail (35mm).

I/O Connectors: Removable plug-in type terminal blocks rated for 15A/300V; AWG #12-24 stranded or solid copper wire.

Enclosure and Physical

Network Connector: 9-pin D-Sub connector (female) with metal housing and 4-40 jack screw support.

D-Sub Pin	Signal	Description
1	SHLD	Shield (Connect to Earth Ground)
2	NC	No Connection
3	A	Data A (TxD/RxD+)
4	RTS	Request To Send
5	GND	RS485 Logic Ground
6	+5V	+5V
7	NC	No Connection
8	B	Data B (TxD/RxD-)
9	NC	No Connection

Case Material: Self-extinguishing NYLON type 6.6 polyamide thermoplastic UL94 V-2, color beige; general purpose NEMA Type 1 enclosure.
Printed Circuit Boards: Military grade FR-4 epoxy glass.
Shipping Weight: 1 pound (0.45 Kg) packed.

Agency Approvals

ProfiBus Trade Organization (PTO): Certified.
Safety Approvals: CE marked (EMC Directive 89/336/EEC); UL Listed (UL508, UL1604); cUL Listed (Canada Standard C22.2, No. 142-M1987 & 213-M1987); Hazardous Locations: Class 1; Division 2; Groups A, B, C, and D.

Environmental

Operating Temperature: -25°C to +70°C (-13°F to +158°F).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.
Power Requirements: Non-polarized 11-36V DC SELV (Safety Extra Low Voltage). Observe proper polarity. See table for current. Note that current draw will decrease up to 8% as the baud rate is increased to 12MB. Data below is at 9600 baud.

CAUTION: Do not exceed 36VDC peak, to avoid damage to the module.

Supply	981/982/983PB-2012 Current Draw
12V	203mA Typical, 224mA Maximum
15V	154mA Typical, 170mA Maximum
24V	94mA Typical, 104mA Maximum
36V	67mA Typical, 74mA Maximum

External Fuse: Select a high surge tolerant fuse rated for 1A or less to protect unit.

CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize equipment before servicing.

Isolation: I/O channel, power, and network circuits are isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). Complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified.

Note that I/O channels are not isolated channel-to-channel.

Installation Category: Designed to operate in an Installation in a Pollution Degree 2 environment with an installation category (over-voltage category) II rating.
Electromagnetic Interference Immunity (EMI): Inputs/outputs do not change states with interference from switching solenoids, commutator motors, and drill motors.

Environmental

These limits represent the minimum requirements of the standard, but product has typically been tested to comply with higher standards in some cases.

Electromagnetic Compatibility (EMC) -

Minimum Immunity Per European Norm EN50082-1:

Electrostatic Discharge (ESD) Immunity: 4KV direct contact and 8KV air-discharge to the enclosure port per EN61000-4-2.

Radiated Field Immunity (RFI): 10V/M, 80 to 1000MHz AM and 900MHz keyed carrier, per EN61000-4-3 and ENV50204.

Electrical Fast Transient Immunity (EFT): 2KV to power, and 1KV to signal I/O per EN61000-4-4.

Conducted RF Immunity (CRFI): 10V rms, 150KHz to 80MHz, per EN61000-4-6.

Surge Immunity: 0.5KV per EN61000-4-5.

Emissions Per European Norm EN50081-1:

Radiated Frequency Emissions: 30 to 1000MHz per EN55022 Class A

WARNING: This is a Class A product. In a domestic environment, this product may cause radio interference in which the user may be required to take adequate measures.

IMPORTANT: Power, input, and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods Article 501-4(b) of the National Electrical Code, NFPA 70 for installations in the U.S., or as specified in section 18-1J2 of the Canadian Electrical Code for installations within Canada and in accordance with the authority having jurisdiction.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, or non-hazardous locations only.

WARNING – EXPLOSION HAZARD – Substitution of components may impair suitability for Class I, Division 2.

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Communication Interface

Interface Standard: 3-wire RS-485 multi-drop, half-duplex (D, D-bar, and Common), asynchronous.

Command/Response Protocol: Standard ProfiBus DP (Master/Slave) protocol per European Norm EN50170.

Baud Rate: Supported baud rates are 9600, 19.2K, 45.45K, 93.75K, 187.5K, 500K, 1.5M, 3M, 6M, and 12M bits per second, auto-detected. Maximum transmission length is dependent on baud rate selection (range is up to 1200M at 9600bps, or up to 100M at 12Mbps). Refer to the following table for maximum transmission distances at supported baud rates using recommended type A (<30pF/M), or alternately type B (<60pF/M) bus wire (see EN50170):

	NETWORK LENGTH	
Baud Rate	**Type A**	**Type B**
9600 bps	1200M	1200M
19.2K bps	1200M	1200M
≤ 93.75K bps	1200M	1200M
187.5K bps	1000M	600M
500K bps	400M	200M
1.5M bps	200M	NA
≤ 12M bps	100M	NA

Communication Interface

Parity: Even parity.
Stop Bits: One.
Communication Distance: Up to 1200 meters without a repeater.
Address: Set via two rotary hexadecimal switches adjacent to the power terminals, or alternately via the Set Slave Address command. Valid setting is 0-125 (7 bits). Address 126 (7EH) is a default factory address reserved for commissioning purposes only. Address 127 (7FH) is reserved by the software as a global address for broadcast messages. If the address switches are set to 126 upon power-up (or 126 to 254), then the unit will retrieve its address from its internal EEPROM rather than the switches. The internal EEPROM setting is modified via the Set Slave Address command. Powering up with switches set to 255 (FFH) will cause the internal EEPROM setting to revert back to 126 (7EH), which may be used to re-commission the module. If both the internal EEPROM address and the switches are set to 126 upon power-up (this is the initial state from the factory), the module will await the Set Slave Address command before completing initialization and assuming the data exchange mode.

IMPORTANT (Address Setting): The internal EEPROM address setting and external switch setting is 126 from the factory. As such, the module will await the Set Slave Address command following power-up and will not proceed to exchange data, unless the external switches are instead set to an address from 0-125, or the internal setting is changed to an address from 0-125 via the Set Slave Address command.

Maximum Message Size: Up to 32 bytes recommended, extendable up to 244 bytes of data/node/message, plus 11 bytes of overhead (frame).
ProfiBus Character: 11 bits (1 start bit + 8 data bits + 1 even parity bit + 1 stop bit). Applies to all bytes, including frame bytes.
Bus Idle State: "1" (a start bit causes line to go to "0"). An idle state of at least 33 Tbits (sync-time) must be provided between messages. Note: 1Tbit at 12Mbaud = 1/12000000bit/sec = 83nsec.
Ident_Number: 06F3 Hex (981PB-2012), 06F2 Hex (982PB-2012), 06F1 Hex (983PB-2012).
GSD File: ACRO06F3.GSD (981PB-2012), ACRO06F2.GSD (982PB-2012), ACRO06F1.GSD (983PB-2012).
Network Capacity: Multi-drop up to 31 modules, plus a host, without a repeater. Up to 125 modules plus a host if four repeaters are used (one for every 31 nodes).
Network Termination: Use 220Ω "A" to "B", plus 390Ω "A" to GND, and 390Ω "B" to +5V. Use ±2%, 0.25W resistors.

Controls & Indicators

LED Indicators:

Run (Green) - Constant ON if power is on and unit is OK. Flashing ON/OFF indicates unit is performing diagnostics (first few seconds after power-up), or has failed diagnostics (after a few seconds).
Bus (Yellow) – ON indicates unit has completed its initialization sequence and is in the data exchange mode on the network.
Output (Yellow, One Per Output) – ON if output relay is ON (closed).

Module-Specific Parameters

This model includes three user parameterization bytes (User_Prm_Data) defined as follows:

Byte	Description	Default
0	Do Not Use - Reserved for SPC3 ASIC.	NA
1	(982/983PB Only) Action taken in Clear Mode or upon watchdog timeout. 00H = Clear outputs (set all outputs to zero). 01H = Do not change (maintain last output states). 02H = Set outputs according to user definition in bytes 1 and 2 defined below.	00H
2	(982/983PB Only) Output Data lower byte (bits 0-7 for digital outputs 0-7). Bit position determines output channel. 0 = Output OFF, 1 = Output ON.	00H
3	(982/983PB Only) Output Data upper byte (bits 8-11 for digital outputs 8-11, bits 12-15 are not used and set to 0). Bit position determines output channel. 0 = Output OFF, 1 = Output ON.	00H

This model does not include any user defined diagnostic data (Ext_Diag_Data).

Data Types

I/O values of Acromag 9xxPB modules are represented by the following simple data types for temperature, percentage, and discrete on/off. Note that when transferring words, data bytes are transmitted using "Big Endian" format (MSB first, LSB second).

Data Types	Description
Percentage	A 16-bit signed integer value with resolution of 0.005%/lsb. ±20000 is used to represent ±100%. For example, -100%, 0% and +100% are represented by decimal values –20000, 0, and 20000, respectively. The full range is –163.84% (-32768 decimal) to +163.835% (+32767 decimal).
Temperature	A 16-bit signed integer value with resolution of 0.1°C/lsb. For example, a value of 12059 is equivalent to 1205.9°C, a value of –187 equals –18.7°C. The maximum possible temperature range is –3276.8°C to +3276.7°C.
Discrete (This Model)	A discrete value is generally indicated by a single bit of an 8-bit byte. The bit number/position typically corresponds to the discrete channel number. Unless otherwise defined for outputs, a 1 bit means the corresponding output is closed or ON, a 0 bit means the output is open or OFF. For active-high inputs, a value of 1 typically means the input is in its high state (usually >> 0V), while a value of 0 specifies the input is in its low state (near 0V). I/O channels of this model are active-low. For active low inputs, a value of 1 means the input is ON (Active low near 0V), while a value of 0 specifies the input is OFF or in its high state (usually >> 0V).